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ANIMATED GRAPHICS SIMULATION MODEL FOR AIRPORT PEDESTRIAN FLOWS

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Prepared for:

Transportation Development Centre

Prepared by:

IMC Management Consultants Inc.

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17. Abstract

The Airport Graphics Simulation Model (AGSM) is a micro-computer software package for the analysis of pedestrian flows in air terminals. It allows airport planners and operations personnel to assess quickly and efficiently the impact of scheduling, gate assignment and terminal configuration changes.

Two input files are required to run a simulation: a terminal layout file created with the airport definition module of AGSM, and a data file containing the detailed time history of pedestrian densities for the case being studied. At this initial stage of development, the latter is calculated externally by a separate traffic flow simulation model. Output can be presented in two modes. The first is an overview format that displays the terminal in plan view and depicts changing pedestrian densities by color codes. The second is a close-up view, pictorial and graphical, of congestion in specific areas.

The model is written in PASCAL and can be run on the IBM PC, IBM XT, IBM AT or compatible hardware.

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17. Résumé

Le rapport dont il est rendu compte ici concerne la simulation infographique de la circulation dans une aérogare, grâce au programme appelé AGSM. Ce programme permet aux projeteurs et aux exploitants d'un ensemble aéroportuaire d'analyser rapidement et efficacement l'effet de tout changement dans les horaires, l'agencement spatial de l'aérogare ou l'affectation des portes d'embarquement.

Pour effectuer une simulation, il faut deux fichiers d'entrée: un représentant le tracé en plan, créé par l'usager lui-même, et un donnant les variations dans le temps d'affluence; présentement, celles-ci sont établies par un modèle mathématique séparé. En sortie, le programme fournit une simulation à deux niveaux: une simulation macroscopique qui surimpose au tracé en plan les niveaux d'affluence indiqués par un code couleur, et une simulation détaillée infographique et analogique (courbes) montrant l'affluence dans un secteur donné.

Le programme, écrit en langage PASCAL, peut fonctionner sur ordinateur PC, XT ou AT d'IBM ou tout autre matériel compatible.

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SUMMARY

The Animated Graphics Simulation Model (AGSM) for airport pedestrian flows is a micro-computer software package which depicts the flow of pedestrians in an air terminal building. This package is a tool which will enable airport planners and operations personnel to review and analyze traffic flows and develop solutions to congestion in air terminal buildings in a timely and efficient manner.

A modular approach has been taken in developing the model. Thus, the model maintains a high degree of flexibility with respect to its input parameters and output presentation. Two input files are required to run a simulation; an airport layout file and a simulation file. The user creates the airport layout file, which contains the terminal building plan and area definitions by using the model's mini-CAD package. The simulation file contains area pedestrian populations calculated by a traffic flow simulation model, which must be organized in a format expected by the AGSM.

Two output presentation modes are available to the user. The first is an overview format, or macro-scale simulation, which displays the terminal building in plan view and depicts the level of pedestrian congestion in specified areas by changes in predetermined color codes. The second is a detailed view, or micro-scale simulation, which displays pedestrians in specific air terminal building areas, as well as line graphs providing information relevant to the area's congestion in the hour both preceding and after the current simulation time.

The AGSM is menu driven, requiring only single key inputs by the user. It is written in PASCAL (computer programming language) and was developed on an IBM XT compatible computer. The model can be run on the IBM PC, IBM XT, IBM AT or compatible hardware. It requires an IBM Enhanced Graphics Adapter or compatible, with a minimum 128k graphics memory.

The AGSM holds the potential to significantly enhance the analysis of airport pedestrian flows by making the results of traffic flow simulation models readily accessible to a wider variety of users, on an interactive basis.

SOMMAIRE

La simulation infographique de la circulation dans une aérogare peut se faire grâce à un programme appelé AGSM. Celui-ci permet aux projeteurs et aux exploitants d'un ensemble aéroportuaire d'analyser les mouvements à l'intérieur de l'aérogare afin de trouver des solutions raisonnées et opportunes aux fortes affluences qui s'y font sentir.

Ce programme infographique comporte plusieurs modules qui lui confèrent une bonne souplesse d'utilisation, tant au niveau de l'entrée des données qu'à celui de l'information produite. Pour effectuer une simulation, il faut deux fichiers d'entrée: un pour représenter le tracé en plan de l'aérogare et que l'usager doit créer lui-même en s'aidant du logiciel DAO fourni, et un pour la simulation de la circulation. Ce dernier montre les variations dans le temps de l'affluence, établies grâce à un modèle mathématique séparé et organisé de manière à se conformer au format du programme AGSM.

En sortie, le programme fournit une simulation à deux niveaux: une simulation macroscopique qui surimpose au tracé en plan les niveaux d'affluence indiqués par un code couleur de convention, et une simulation détaillée qui montre l'affluence dans un secteur donné. Dans ce cas, l'information affichée donne graphiquement l'affluence instantanée, flanquée des courbes de variation de l'affluence durant l'heure précédente et l'heure suivante.

Sur l'écran, un menu des commandes possibles est affiché, la sélection se faisant grâce à un clavier. Le langage utilisé est le PASCAL. Le programme établi à l'origine sur un ordinateur compatible avec le XT d'IBM peut fonctionner aussi bien sur les modèles PC et AT d'IBM que sur tout autre matériel compatible. Il faut lui adjoindre un module d'amélioration d'image, IBM ou compatible, devant comporter au moins 128 kbits de mémoire graphique.

Ce programme de simulation devrait permettre de régler plus efficacement les problèmes de congestion des aérogares du fait que les simulations, maintenant en mode conversationnel, se trouvent à la portée d'une gamme plus étendue d'utilisateurs.

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1.0 INTRODUCTION

The Animated Graphics Simulation Model (AGSM) for aiport pedestrian flows is a micro-computer software package which depicts the flow of pedestrians in an air terminal building. This package is intended to assist airport planners and operations personnel both in analyzing and developing solutions to air terminal building congestion.

1.1 Background

The Quantitative Systems Division of the Airport Planning Branch of Transport Canada have developed several computer models to assist planners and designers in evaluating demand, the level of service and required investment in airport facilities. Each of these models produces a distinct output which can be either utilized for analysis or as input to another model. In general terms, their functions can be summarized as follows:

- o Generate a schedule of aircraft arrivals and departures.
- o Assign gate positions to aircraft.
- o Simulate the flow of pedestrians through an air terminal building.

1.2 Function of the Animated Graphics Simulation Model

The function of the AGSM is to depict the flow of pedestrians through an air terminal building. This model utilizes the output of a Traffic Flow Simulation Model (TFSM) which produces pedestrian populations for identifiable and discreet areas of interest in a terminal building. The AGSM compares these populations with level of service capacity guidelines for the area. Pedestrian flow is simulated by changes in color of identified terminal building areas which correspond to changes in the calculated level of service.

The AGSM is intended to enhance the accessibility of TFSM output, by providing the user a tool with which to quickly review and assess the impact of scheduling, gate assignment, and terminal building configuration changes. Thus, the existing users of TFSM's will benefit from the AGSM by saving time which would largely be spent going through a series of computer print-outs. In addition, the development of a micro-computer TFSM, compatible with the AGSM, will enhance the applicability of both models to the airport planning and operations functions by allowing users to change the relevant parameters and view the results in a timely fashion.

1.3 Importance of the Traffic Flow Simulation Model

It must be recognized that the AGSM requires outputs from a TFSM to be functional. The AGSM does not produce pedestrian flow or area population data, but rather can be viewed as an interpreter of this

information. This highlights the importance of the TFSM. The accuracy, and subsequent relevance of the results presented by the AGSM depends almost wholly upon the quality of the TFSM.

1.4 Report Structure

This report summarizes the objectives and capabilities of the Animated Graphics Simulation Model. Following this brief introductory section, Section 2 describes the approach taken in developing the model, Section 3 discusses the model's output presentation and operating features, Section 4 defines the model's initialization and input requirements, Section 5 discusses the program's software utilization and hardware requirements, Section 6 summarizes the project's achievements and Section 7 provides recommendations for enhancement of the AGSM and related planning models.

In addition to this report, two manuals have been prepared and delivered to the Quantitative Systems Division to assist in Transport Canada's use of the model. The first is a User's Manual, which describes the features of the model and the user/model lexicon. The second is a Systems Manual, which outlines the hardware requirements and software environment utilized by the model. In addition, this manual details the AGSM's program structure, procedures and sub-routines.

2.0 MODEL DEVELOPMENT

This section outlines the approach taken in developing the Aminated Graphics Simulation Model. In addition, it describes the basic parameters used to both develop and test the model.

2.1 Development Team

The overall direction of the project was guided by a development team comprised of representatives from the Transportation Development Centre, Quantitative Systems Division, Western Region Airport Services and the Edmonton International Airport. The project was entirely funded by the Transportation Development Centre. The team approach taken in this project proved to be extremely beneficial, especially in terms of providing a product which not only will meet the needs of a variety of users, but is also compatible with the existing airport planning models.

2.2 Approach

The overall approach taken in developing the AGSM is designed to maximize the model's flexibility. This refers to its compatibility with relevant existing and anticipated software, its adaptability to changing needs, and applicability to a full range of applications.

2.2.1 Compatibility

Because the functionality of the AGSM depends upon the output of other computer models, it is essential that it easily interface with these models. This has been achieved via a modular approach to the model's development.

The AGSM has been developed as an inclusive module, which does not actively interact with the TFSM, but rather acquires the source pedestrian population data from a TFSM output file, which has been assembled in a form expected by the AGSM (the detailed specification of this file is discussed in the Systems Manual). This approach has several advantages, including:

- It allows programming revisions to be made to either model without creating errors in the other (this does not include changes which affect the compilation or reading of the TFSM output file).
- Eliminates the need for additional programming effort to develop an interactive component.
- Allows flexibility with respect to the programming language used for each model.
- Allows the AGSM to run more quickly.
- Creates user flexibility by facilitating a simulation rewind feature.

2.2.2 Adaptability

The modular approach has been carried further within the AGSM itself. The model comprises three modules, briefly described as follows:

- o Airport Definition Module: A mini-CAD package used to define the air terminal building and the specific areas modelled.

- o Macro-Scale Simulation Module: Produces a plan-view, color coded simulation of pedestrian traffic flows.

- o Micro-Scale Simulation Module: Produces a detailed view of a specified terminal building area, as well as line graphs depicting the status of the area.

Each of these modules performs a specific and distinct function (these modules are described in more detail in the User's Manual). As discussed above, this modular approach facilitates the adaptability of the model to future requirements by allowing individual modules to be enhanced without requiring major adjustments to the entire program.

2.2.3 Functional Flexibility

Central to the impetus for developing the AGSM is to not only enhance the interpretation of TFSM output, but to also widen the spectrum of users. It was recognized that this can largely be achieved by maintaining a high degree of functional flexibility in the model. As a result, the existing and potential users' needs were given due consideration in the process of developing the model's key features. These features are briefly summarized as follows:

- o Outputs: The display of outputs provides both an overview and detailed analysis capability.

- o Adaptability: The model has been designed with both input and output features which will allow it to be utilized for air terminal buildings of varying size and complexity. In addition, it allows for modification of building parameters to test different terminal building configurations.

- o Model/User Interface: The model is menu driven, requiring one key inputs from the user. Where appropriate, messages are provided to explain the model's current status.

- o Hardware: The computer hardware available to the potential users was considered in the selection of the hardware configuration.

An overview of the AGSM's features is provided in Section 3 and also discussed in detail in the User's Manual.

2.3 Development and Testing

The model was developed and tested using the Edmonton International Airport as the base air terminal building configuration. This site is of sufficient size and complexity to ensure the model's applicability to larger terminal buildings.

The model was tested using outputs for the Edmonton International Airport from the Quantitative Systems Division's mainframe TFSM. This data was down-loaded and massaged into the format expected by the AGSM. Preliminary versions of the AGSM have been tested by members of the project development team using this data. Where appropriate, the comments resulting from their tests have been incorporated into the current version of the AGSM.

3.0 FEATURES OF THE ANIMATED GRAPHICS SIMULATION MODEL

The AGSM presents the user with a variety of outputs in two basic formats. This section describes these presentation formats and the specific information provided in each, as well as an overview of the model's operating features used to control the output presentation.

3.1 Output Presentation

As discussed previously, the purpose of the AGSM is to present pedestrian traffic flows in a manner which facilitates its timely interpretation and analysis. This is achieved by providing the user the capability of viewing the TFSM results in two levels of detail. The first is an overview format, or macro-scale simulation, which depicts the level of congestion in specified areas of the air terminal building by changes in predetermined color codes. The second is a detailed view, or micro-scale simulation, which displays pedestrians in a specified area of the terminal building, as well as line graphs providing information relevant to the area's congestion over a two hour simulation period.

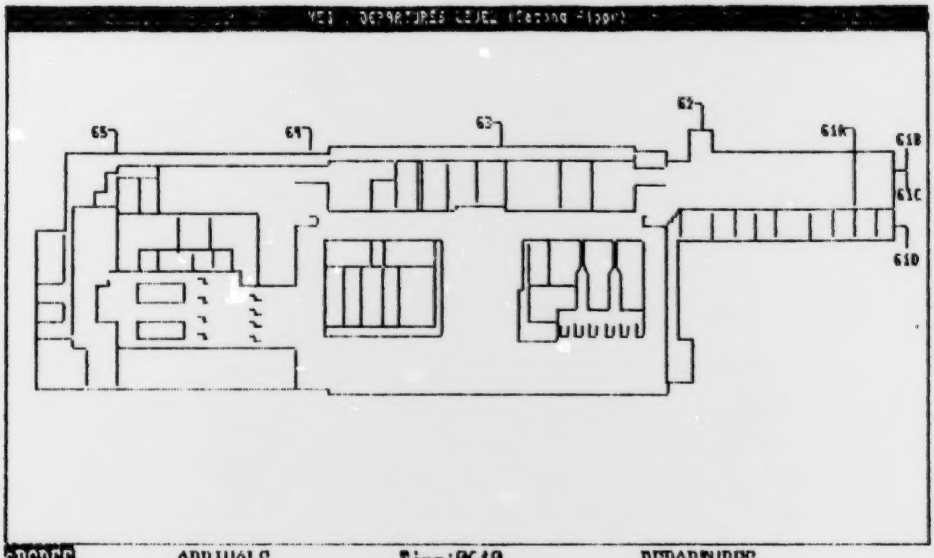
3.1.1 Macro-Scale Simulation Mode

The macro-scale simulation mode provides an overview of the air terminal building traffic flows. Traffic flows are depicted by color changes in predefined terminal building areas. The presentation is in plan view, which for most airports can be displayed on one screen. Where the size of the terminal building prohibits scaling to a single screen, or its shape is not conducive to incorporating the required detail on a single screen, multiple screens, or pages can be used. For example, the Edmonton International Airport is displayed on two pages, with the departures level on one page and the arrivals level another. The Edmonton International Airport departures level is depicted in Figure 3.1.

Color codes have been used to facilitate the monitoring of terminal building congestion utilizing Transport Canada's six planning levels of service. The current degree of congestion and associated color of each area are determined by comparing the areas current population with a table of service levels. The area is then filled with the color which has been selected to depict that level of service. This procedure is carried out for each specified terminal building area, for each simulation time period. As the simulation progresses, the specified terminal building areas will change color according to the determined level of service during that simulation interval.

The terminal building layout and specified areas must be initialized by the user. These areas can be modified to test the impact of alternate configurations on congestion. As well, the user can change the default parameters for level of service thresholds, the associated color codes, speed of the simulation and other parameters. These features are discussed in more detail below in subsequent sections of this report.

FIGURE 3.1 MACRO-SCALE SIMULATION MODE SCREEN
EDMONTON INTERNATIONAL AIRPORT
DEPARTURES LEVEL



ABCDEF ARRIVALS Time:0610 DEPARTURES

Time	Flight	Gate	From	Aircraft	Class	Time	Flight	Gate	To	Aircraft	Class
0645	AC 790	5	YYZ	D9S	D	0615	CO 448	4	LAX	747	D
0715	CO 643	1B	YWG	72S	I	0630	UA 793	1D	YOW	72S	D
0730	WA 951	1A	YWG	D9S	D	0700	AC 665	1B	YOW	747	D
0800	AC 466	1C	YOW	737	I	0745	WD 417	4	YWG	72S	T
0815	AC 126	3	YYZ	72S	T	0830	CP 621	4	YOW	737	T
0930	CO 101	3	YYZ	747	D	0845	CO 979	4	LAX	72S	T

Press action key to pause simulation F:YBG2 Pg:2/2

In addition to the terminal building plan view, which is presented in the top two-thirds of the screen, the macro-scale simulation presents schedule information in the bottom third of the screen. This schedule display includes aircraft arrival and departure times, airline, flight number, gate assignment, flight origin or destination, aircraft type and aircraft class. This schedule information has been used to drive the TFSM and will be helpful to the AGSM user in determining why peak pedestrian volumes and congestion have occurred.

3.1.2 Micro-Scale Simulation Mode

At any point during the simulation, the user can pause the simulation and "zoom-in" on a specified area for a detailed picture of its status. This micro-scale simulation also presents a split screen. The top two-thirds provide a detailed plan view of the terminal building area selected and appropriately displays pedestrians currently in the area. If the area is a processor, the pedestrians are drawn in queues behind active servers in a random fashion, simulating actual queuing. If the area is a hold room, wait area, or baggage area, pedestrians are distributed randomly within the boundaries specified for the area.

Detailed line graphs depicting information relevant to the area of interest are displayed in the bottom one-third of the screen. For each area type, two line graphs are presented representing the status of the areas over a two hour period, one hour before and after the current simulation time.

For each of the four area types, the first graph on the left side of the screen displays the maximum and average pedestrian occupancy in the specified area during each time interval. To assess the degree of congestion, the level of service standards determined for the area can be represented by horizontal lines across the graph. If desired, any or all five levels of service can be displayed on this graph.

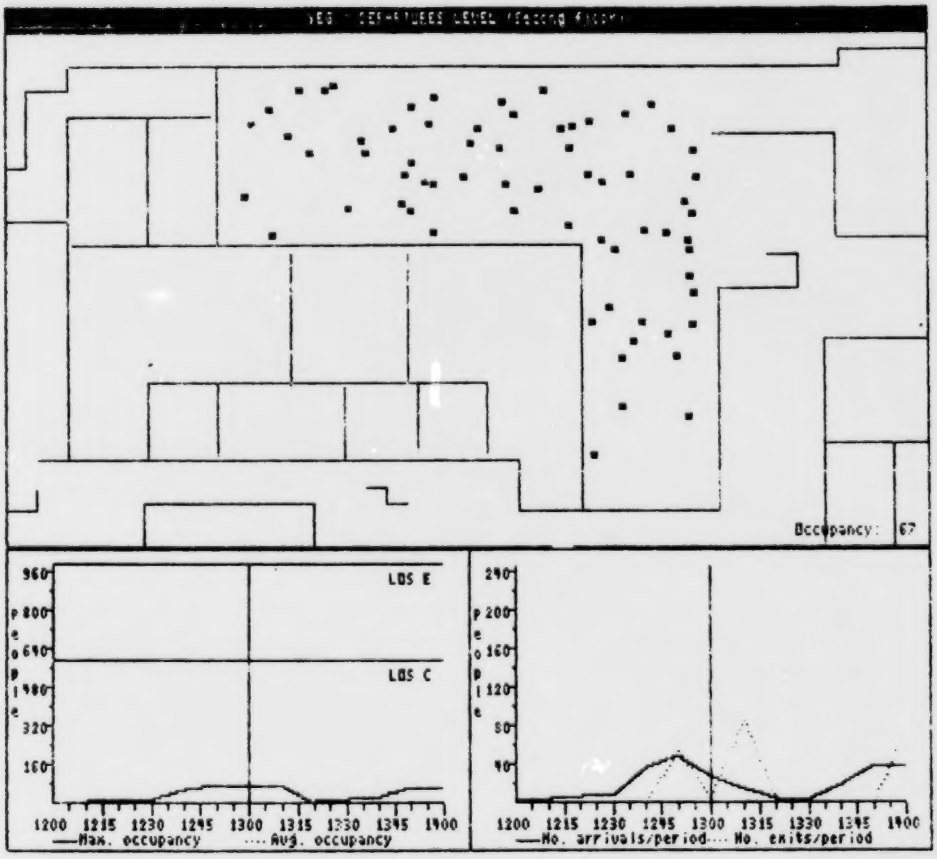
The information presented in the second graph on the right side of the screen varies with the type of area selected as follows:

- Link or Wait/Hold Area: The number of pedestrians entering and exiting the area during each simulation time period.

- Processor or Baggage Claim Area: The maximum and average queue or waiting time of the pedestrians in the area.

When in the micro-scale simulation mode, the user has the option of returning to macro-scale simulation, or proceeding step-wise, backward or forward, through the micro-scale simulation. In addition, the user may print the entire screen, including the detailed area display and two graphs, or a full page print of either graph by itself. An example of this screen is presented in Figure 3.2.

FIGURE 3.2 MICRO-SCALE SIMULATION MODE SCREEN
EDMONTON INTERNATIONAL AIRPORT
HOLD ROOM FOUR



3.2 Operating Features

The AGSM is menu driven, requiring only single key inputs by the user. The menu is presented in the bottom one-third of the screen. During a simulation, this area is replaced with information pertinent to the simulation, as described above. A message area is reserved on the bottom line of the screen to display operating and error messages.

Menu options and simulation operating features are selected by depressing the key of the highlighted letter (usually the first letter) of the desired menu option. The operating features of the AGSM are briefly described below and discussed in detail in the Users Manual.

3.2.1 Beginning a Simulation

Before proceeding with the simulation, the model must be initialized by selecting an airport layout and simulation file. The airport layout file contains the plan view of the terminal building as well as the defined areas modelled. This file must be setup prior to running the simulation. The user may have several layout files for a single site to test the impact alternate configurations have in alleviating a traffic flow or congestion problem.

The simulation file contains the TFSM output required to drive the simulation. As with the layout file, the user may have several simulation files with which to test the sensitivity of passenger flows to changes in pedestrian paths (resulting from changes to the terminal building configuration), the number of active servers at processors or the schedule used to drive the TFSM.

Before beginning the simulation, the user has the option of changing a number of default parameters which affect the presentation of the simulation outputs. These are briefly outlined below:

- Simulation Time: The user can select simulation start and end times to run only a portion of the simulation file. The default start and end times are those of the simulation file.

- Skip Factor: The simulation will proceed displaying the results of each simulation time interval sequentially. If this detail is not desired, the skip factor can be set to select every second, third, etc. up to ninth simulation time interval.

- Delay Factor: Depending upon the processing capability of the hardware, the simulation may run too quickly for the user. The delay factor can slow the simulation by up to 999 milliseconds (almost one second) between intervals.

- Fast Draw: To speed up the macro-scale simulation mode, fast draw can be selected. This option does not redraw background detail within areas filled with color.

- o Even Draw: Again to speed up the macro-scale simulation mode, the user can choose not to refill those areas whose color does not change from period to period.

- o Animate: To speed up the micro-scale simulation mode, the animation option, which draws occupants in the detailed area, can be de-selected.

- o Max/Ave Occupancy: Either the maximum or average area occupancy per time period can be selected to determine the level of service and subsequent color coding.

- o LOS Table: Two Level of Service (LOS) tables are available, the first is a detailed table (19 area types) usually used for engineering design and the second (6 area types) for planning purposes.

3.2.2 Controlling the Simulation

Once the model has been initialized, the presentation parameters have been selected, and the simulation has been initiated, the user has three "action keys" available to control the presentation. These are briefly described as follows:

- o P (Pause the Simulation): The simulation begins in macro-scale and can be temporarily halted by pressing the P key. The simulation can be resumed by pressing the R key.

- O Z (Zoom-in to Micro-scale): At any point during the macro-scale simulation mode, the micro-scale simulation is accessed by pressing the Z key and pointing the cursor to the selected area.

- o ESC (Exit the Simulation): Both the macro-scale and micro-scale simulations can be exited by pressing the ESC key.

When within the micro-scale simulation mode, the user can step through the simulation, either backwards or forwards, using the directional keys. The micro-scale simulation mode screen and line graphics can be printed in combination or separately.

4.0 MODEL INPUTS AND INITIALIZATION PARAMETERS

Prior to running a simulation on the AGSM, input files must be created and the model's operational parameters initialized. Model input files consist of the airport layout and simulation files which are specific to an airport site and incorporate assumptions regarding the terminal building configuration and pedestrial flows. The model's operation parameters are the default values imbedded in the model which control color options, graph parameters, flow simulation parameters and level of service thresholds. These two types of information requirements are distinguishable by their function. Both are necessary to successfully run a simulation, however, the input files are specific to a particular site and a set of assumptions regarding pedestrian flows at that site. The initialization parameters are specific to the users tastes and purpose.

4.1 Model Inputs

As discussed in the previous section, both an airport layout and simulation file must be selected prior to commencement of a simulation. These files and their composition are briefly described below.

4.1.1 Airport Layout File

The airport layout file is created and edited using the AGSM's airport definition module. This module consists of a mini-CAD package used to draw the airport in plan view and define the areas to be monitored. Once an airport layout file is created, it is saved for future use. The master file may be altered or edited to reflect either anticipated or desired changes in the terminal building's configuration. These revised configurations may be saved as separate files, and (given appropriate adjustments to the TFSM) used to test the effect anticipated or hypothetical alterations to the terminal building have on pedestrian traffic flows or congestion.

Utilizing the mini-CAD package, the plan view of the air terminal building can be drawn to the level of detail required. Once this is completed, the specific areas to be monitored must be defined and labelled.

Four basic types of areas are modelled to analyze pedestrian traffic flows in an air terminal building. These include:

- Links: Connectors to more specialized airport areas.
- Wait/Hold Areas: Areas where passengers and meeter/greeters wait for flights to arrive or depart.
- Processors: An area where passengers are served by airline and airport personnel.
- Baggage Claim Areas: Areas where arriving passengers claim their baggage.

Each area defined is labelled by both an area number and area type. The area number corresponds to the area's number in the TFSM and thus facilitates the assignment of the appropriate population values to the subject area. The area type ties the area to a specific vector of level of service thresholds.

The area definition also consists of drawing the subject area's boundaries. It is within these boundaries that the color depicting the area's current level of service is shown. In addition, these boundaries are used to calculate the physical area of the area defined. This calculation is used to determine the level of service and congestion at each simulation time interval.

For wait/hold areas, the determination of the area boundaries is relatively straight-forward as these area types usually have well defined limits. In the case of processors and baggage claim areas, the boundary definition is somewhat more arbitrary, as it is not always clear where these areas end and adjacent areas, which are usually links, begin. It should be noted that this is not a critical problem if judgement is used in the interpretation of simulation presentation. Because in practice, usually no physical boundaries exist between wait/hold areas or baggage claim areas and links, pedestrians will utilize available space and optimize their own inter-personal distance within the space available. Thus regardless of the specific boundaries defined for an area, the AGSM user should recognize that if a specified area is severely congested, with low or moderate congestion in the adjacent areas, that in practice the pedestrians in the congested area will spill over into the adjacent areas. Likewise, if the adjacent areas are also severely congested, the problem is more severe as there is no place for the congestion to be spread over. This discussion highlights the problems associated with analyzing traffic flows in a "piece meal" fashion.

4.1.2 Simulation File

The simulation file contains TFSM outputs which are read by the AGSM, and drive the AGSM simulation. This file must consist of specific pedestrian flow information in a specific format. The outputs expected by the AGSM are:

Links:	Maximum occupancy (persons)
	Average occupancy (persons)
	Number of arrivals (persons)
	Number of exits (persons)
Processors:	Maximum queue length (persons)
	Average queue length (persons)
	Maximum queue time (minutes)
	Average queue time (minutes)
	Number of servers open

Wait/Hold: Areas	Maximum occupancy (persons) Average occupancy (persons) Number of arrivals (persons) Number of exits (persons)
Baggage: Claim Areas:	Maximum occupancy (persons) Average occupancy (persons) Maximum wait time (minutes) Average wait time (minutes) No. of bags on the device

These outputs must be identified by area number to be cross-referenced with the areas defined in the airport layout file. In addition, each output must be associated with a specific simulation time period to drive the simulation. The simulation file also should have attached to it the schedule information used by the TFSM to derive these outputs, for presentation in the macro-scale simulation mode (this file is not necessary for the operation of the simulation).

4.2 Initialization Parameters

Prior to running the AGSM, the initialization parameters should be confirmed. These parameters pertain to the default values used for the colors indicating level of service, detailed graph parameters, flow simulation parameters and the level of service thresholds. These are relevant to each individual user's preferences and functional purpose, and can be adjusted and saved so as to be automatically loaded each time a simulation is run.

- Color Options: Sixteen color options are available to the user for text, terminal building plan and area boundaries, graph colors and background color. As well, the default colors associated with each level of service can be specified.

- Graph Parameters: The graphs presented in the micro-scale simulation mode can be customized for specific users or functions. Parameters which can be adjusted include: the data series displayed, Y-axis scale, and Y-axis labels.

- Flow Simulation Parameters: As these parameters control the simulation presentation, they can be adjusted prior to starting the simulation. However, permanent adjustments can be made to their default values in this file.

- Level of Service Parameters: The level of service parameters can be adjusted to meet specific site requirements, or accommodate permanent changes in standards.

5.0 HARDWARE/SOFTWARE CONFIGURATION

The AGSM has been designed to run on an IBM Personal Computer of the following configuration:

- IBM-PC, IBM-XT, IBM-AT, or other 100% compatible
- IBM Personal Computer DOS release 2.0 or higher, or MS-DOS release 2.11 or higher
- 128k installed RAM minimum, 384k RAM desirable
- 1 floppy disk drive minimum, 1 floppy disk drive and 10 Megabyte hard disk or greater desirable
- an IBM Enhanced Color Display monitor or compatible with a minimum of 128k graphics memory. A regular Color Graphics Adapter (CGA) or monochrome card will not work with the system.

The above environment is the 'run-time' environment. A hard disk (10 MB minimum) and 256k RAM are required in order to modify and compile the source code.

The software required to run the AGSM consists of eight files occupying approximately 135,000 bytes on one floppy disk. For optimum use of the AGSM a hard disk is recommended. The software development environment was "TURBO PASCAL", in conjunction with the "TURBO GRAPHIX TOOLBOX", a graphics library well-suited for applications such as the AGSM. Both software products are produced by Borland International Ltd. The Systems Manual provides an overview of the development language and reasons for its use.

6.0 CONCLUSION

The AGSM is a tool which will enable airport planners and operations personnel to review and analyze air terminal building traffic flows and congestion in a timely and efficient manner. In addition, it has the potential to significantly enhance the analysis of airport pedestrian traffic flows by making the results of traffic flow simulation models readily accessible to a wider variety of users, on an interactive basis.

7.0 RECOMMENDATIONS

Presently, the TFSM outputs required to drive the AGSM are produced by the Quantitative Systems Division's mainframe TFSM. While outputs from this, or other TFSM models are greatly enhanced by the AGSM, the separation of the models severely limits the envisioned functional capability of the AGSM. What is required is a micro-computer TFSM which can be run in conjunction with the AGSM, thus allowing the user complete flexibility to test the sensitivity of terminal building traffic flows and congestion to changes in TFSM parameters in a single continuous session. This feature would also yield both the TFSM models and AGSM suitable for analyzing operational and short-term planning problems.